(19) Patent office of Japan (JP) (11) Publication of Patent Application

(12) **JAPANESE PATENT APPLICATION (KOKAI) (A)**

Hei-Sei 9-248771

(51) Int. CL.5 ID Code Office Cont'l Nbr. (43) Publication: Hei-Sei 9 (1997) 9/22

B 24 D 11/00B
B 24 B 19/00J

Verification Request: not requested

Number of claims of the invention: 5 OL

Number of pages (8)

---

(54) Name of the invention: Polishing Tape Used for the Edge Surface of Optical Connector Ferrule, Polishing Method Used for the Edge Surface of Optical Connector Ferrule, and Polishing Equipment Used for for the Edge Surface of Optical Connector Ferrule

(21) Filed Number: Hei- Sei 8-58035

(22) Filed date: Hei-Sei 8 (1996) 3/14

Patent Assignee: Dai Nippon Insatsu Company

JP 9-248771

[Note : Names, addresses, Company names and brand names are translated in the most common manner. Japanese Language does not have singular or plural words unless otherwise specified with numeral prefix or general form of plurality suffix. Translator's note.]

(54) [Name of the invention]

Polishing Tape Used for the Optical Connector Ferrule Edge Surface, Polishing method for the Optical Connector Ferrule Edge Surface and Polishing Equipment Used for the Optical Connector Ferrule Edge Surface

(57) [Summary]

[Subject]

To suggest polishing tape, polishing method and polishing equipment that is appropriate for the final finish of the optical connector ferrule edge surface.

[Solution measures]

An optical connector ferrule edge surface polishing tape is provided that has a substrate material used for polishing tapes, and a polishing layer that is provided on the top of this substrate material, where the substrate material that is used in the above described polishing tape is a polyester film that has a thickness in the range of 50 ~ 100 microns, and where the polishing layer that is provided on the top of the above substrate material contains polishing (abrasive) particles that are formed from silica particles that have an average particle diameter in the range of 5 ~ 30 microns, and a binder agent that binds these particles, and also where the center line average roughness Ra of the surface of the polishing layer is in the range of 0.005 ~ 0.2 microns. The polishing tape is placed on the top of a rotating metal plate with an elastomer elastic material inserted between them. As the rotating metal plate is rotated, together with that water is used as a lubricating agent and while that water flows, the edge surface of the optical connector ferrule, that is formed from the optical fiber and the covering part that covers this optical fiber, is pushed against the polishing layer of the polishing tape.

[Range of the claims of the invention]

[Claim 1]

An optical connector ferrule edge surface polishing tape is provided that has a substrate material used for polishing tapes, and a polishing layer that is provided on the top of this substrate material, where the substrate material that is used in the above described polishing tape is a polyester film that has a thickness in the range of 50 ~ 100 microns, and where the polishing layer that is provided on the top of the above substrate material contains polishing (abrasive) particles that are formed from silica particles that have an average particle diameter in the range of 5 ~ 30 microns, and a binder agent that binds these particles, and also where the center line average roughness Ra of the surface of the polishing layer is in the range of 0.005 ~ 0.2 microns.

[Claim 2]

An optical connector ferrule edge surface polishing tape according to Claim 1 of the present invention, characterized by the fact that the polishing layer is a polishing layer that is formed from a mixed material containing silica particles and magnesium oxide particles with an average particle diameter in the range of 5 ~ 30 microns.

[Claim 3]

An optical connector ferrule edge surface polishing tape according to Claim 1 or Claim 2 of the present invention, characterized by the fact that the binder agent is a siloxane bond containing polymer, or its prepolymer or oligomer, or it is a vinyl chloride - vinyl acetate copolymer material.

[Claim 4]

Polishing method for the polishing of the edge surface of an optical ferrule, characterized by the fact that it encompasses the following technological processes:

the technological process of providing an optical connector ferrule edge surface polishing tape that has a substrate material used for polishing tapes, and a polishing layer that is provided on the top of this substrate material, where the substrate material that is used n the above described polishing tape is a polyester film that has a thickness in the range of 50 ~ 100 microns, and where the polishing layer that is provided on the top of the above substrate material contains polishing particles that are formed from silica particles that have an average particle diameter in the range of 5 ~ 30 microns, and a binder agent that binds these particles, and also where the center line average roughness Ra of the surface of the polishing layer is in the range of 0.005 ~ 0.2 microns;

the technological process where the polishing tape is placed on the top of a rotating metal plate with an elastomer elastic material inserted between them;

the technological process where as the rotating metal plate is rotated, together with that water is used as a lubricating agent and while that water flows, the edge surface of the optical connector ferrule, that is formed from the optical fiber and the covering part that covers this optical fiber, is pushed against the polishing layer of the polishing tape.

[Claim 5]

Polishing equipment for the polishing of the edge surface of an optical ferrule, where
a rotating plate,
a substrate material used for polishing tapes,
a polishing layer that is provided on the top of that substrate material,
a mechanism for the rotation start-up of the above described rotating plate,
a device for supplying water or alcohol as the lubricating agent, onto the edge surface of the above described optical ferrule, are provided,

and where an optical connector ferrule edge surface polishing tape, that has a substrate material used for polishing tapes, and a polishing layer that is provided on the top of this substrate material, and where the substrate material that is used in the above described polishing tape is a polyester film that has a thickness in the range of 50 ~ 100 microns, and where the polishing layer that is provided on the top of the above substrate material contains polishing particles that are formed from silica particles that have an average particle diameter in the range of 5 ~ 30 microns, and a binder agent that binds these particles, and also where the center line average roughness Ra of the surface of the polishing layer is in the range of 0.005 ~ 0.2 microns, is placed on the top of the above described rotating plate,

and where the edge surface of the optical connector ferrule, that is formed from the optical fiber and the covering part that covers this optical fiber, is pushed against the polishing layer of the above described polishing tape.

[Detailed description of the invention]

[0001]

[Technological field pertinent to the present invention]

The present invention is an invention about a polishing tape, polishing method and polishing equipment for the edge surface of optical connector ferrule that is the final finishing polishing of the edge surface of an optical connector ferrule, and where a polishing is conducted so that there is no scratching of the edge surface of the optical connector ferrule, and also, there is no generation of step difference in

the space between the ferrule and the optical fiber that is appropriate for designing an improvement of the optical properties, and especially the reflection decrease amount.

[0002]

[Previous technology]

In the past, for the connection of the optical fibers in the optical fiber communication networks, the easily removable optical connectors have been widely used. In the connection, the edge surfaces of the optical fiber ferrule, that is formed from the optical fiber and the cover part that covers the optical fiber (ferrule) are directly protruding to each other, and because of that, at the time of the connection, the optical properties and especially the reflection decrease amount, depend on the processing properties and state and the accuracy of the edge surface of the optical fiber ferrule.

[0003]

And namely, the edge surface of the optical fiber ferrule is processed by conducting a several step polishing technological process. However, depending on the processing properties and accuracy of the polishing technological process that is conducted in the final finish process, the product quality varies, and in this final finish polishing, the so-called mechanical polishing technological process is conducted.

[0004]

The mechanical polishing of the edge surface of the optical connector ferrule is conducted according to the described here below, Namely, first, in an alkali solution like caustic soda, ammonia, ethanol amine etc., polishing material particles that have a particle diameter in the range of 5 ~ 300 microns, are suspended, and by that a polishing fluid is prepared that is formed from a colloid liquid with a pH in the range of 9 ~ 12. After that, this polishing liquid is supplied on the top of a polishing fabric that is formed from a polyurethane etc., resin sheet, at the same time the optical connector ferrule edge surface is polished on the polishing fabric. Also, as a separate polishing method, as described here below, the polishing methods have been tried where different types of polishing tapes have been used.

[0005]

[Problems solved by the present invention]

Regarding the mechanical polishing that appropriately uses a polishing cloth and a polishing solution, such as that described here above, it is possible to use relatively small abrasive particles and because of that, it is possible to expect a high precision polishing technological process. However, there are the described here below

problems.

[0006]

Namely, because of a change in the concentration of the abrasive material particles in the polishing fluid during the polishing, or because of a change of the particle distribution of the abrasive material particles due to agglomeration of the abrasive material particles, there is a generation of polishing scratches or polishing blemishes on the edge surface of the optical connector ferrule. Regarding such generated polishing scratches or polishing blemishes, they become sources for light reflection, and because of that, there is the problem that it has been said that the optical signal in the past has been noisy. Also, after the completion of the polishing of the optical connector ferrule, it is necessary to have a technological process for washing and eliminating the polishing material particles that have adhered onto the edge surface of the optical connector ferrule, and because of that, the polishing technological process is a complex one.

[0007]

Contrary to that, the authors of the present invention have manufactured a polishing tape where onto a substrate material, that is used for polishing tapes and that is formed from a plastic film material, a coating agent material, that is formed as in a resin solution, that is used as the bonding agent (binder), polishing material particles are dispersed, is coated and dried, and by that a polishing layer is formed. And they have attempted to use that tape in the polishing technological process that is conducted as the final finish on the edge surface of the optical connector ferrule.

[0008]

Namely, a polishing sheet is produced where as the substrate material, a polyester film is used that has a thickness of 50 microns, and as the binder agent, polyester type resin, polyester urethane type resin, is used, and as the abrasive material particles, diamond or alumina particles are used where the average particle diameter is at least 1 micron and above. And then, this is used as the polishing sheet used for the final finishing polishing of the edge surface of the optical connector ferrule. However, in the case when this polishing tape is used, because of the properties of the binder agent, the properties of the polishing material, the particle diameter and the surface roughness of the polishing layer, there is a generation of polishing scratches on the edge surface of the optical connector ferrule, and not only that, but also, there is the problem of the generation of step in the space between the ferrule and the optical fiber. And that is why it is not preferred.

[0009]

Namely, in the case when the binder agent of the polishing tape is formed from polyester type resin, or polyester urethane type resin, as described here above, the

dispersibility properties of the abrasive material particles in the binder agent are not good, and because of that, even in the case when the abrasive material particles that are used have an average particle diameter of less than 1 micron, because of the agglomeration of the abrasive material particles, it is easy to obtain large particles that are 1 micron and above. Also, in the case when the abrasive material particles in the polishing layer of the polishing tape are high hardness like an alumina etc., ceramics or a diamond, together with the high hardness of these polishing material particles, the center line average roughness of the surface of the polishing layer becomes large at around 0.3 microns. In this case, because the ferrule has a structure that is formed from zirconia etc., hard ceramics, and relative to the optical fiber in the center, it is difficult to polish, the relatively soft material optical fiber is polished more, and as a result from that, the optical fiber is inserted into the ferrule and a step is generated in the space between the optical fiber and the ferrule. In the case when this way, if the optical fiber is inserted, and 2 optical connector ferrules are protruded and connected to each other, there is a generation of a gap in the space between the optical fibers of the two optical connector ferrules, and at the time of the signal propagation a light reflection is generated.

[0010]

As described here above, even in the case of using a polishing tape, there are different problems, and there has not been a case where the desired and expected goals have been accomplished t satisfactory.

[0011]

The present invention is an invention that has taken into consideration these points, and it is an invention that has a s a goal to suggest a polishing tape, polishing method and polishing equipment for the edge surface of optical connector ferrule that is the final finishing polishing of the edge surface of an optical connector ferrule, and where a polishing is conducted so that there is no scratching of the edge surface of the optical connector ferrule, and also, there is no generation of step difference in the space between the ferrule and the optical fiber that is appropriate for designing an improvement of the optical properties, and especially the reflection decrease amount.

[0012]

[Measures in order to solve the problems]

The invention according to Claim 1 of the present invention is an optical connector ferrule edge surface polishing tape is provided that has a substrate material used for polishing tapes, and a polishing layer that is provided on the top of this substrate material, where the substrate material that is used in the above described polishing tape is a polyester film that has a thickness in the range of 50 ~ 100 microns, and where the polishing layer that is provided on the top of the above substrate material

contains polishing (abrasive) particles that are formed from silica particles that have an average particle diameter in the range of 5 ~ 30 microns, and a binder agent that binds these particles, and also where the center line average roughness Ra of the surface of the polishing layer is in the range of 0.005 ~ 0.2 microns.

[0013]

The invention according to Claim 2 of the present invention is an optical connector ferrule edge surface polishing tape according to Claim 1 of the present invention, characterized by the fact that the polishing layer is a polishing layer that is formed from a mixed material containing silica particles and magnesium oxide particles with an average particle diameter in the range of 5 ~ 30 microns.

[0014]

The invention according to Claim 3 of the present invention is an optical connector ferrule edge surface polishing tape according to Claim 1 or Claim 2 of the present invention, characterized by the fact that the binder agent is a siloxane bond containing polymer, or its prepolymer or oligomer, or it is a vinyl chloride - vinyl acetate copolymer material.

[0015]

The invention according to Claim 4 of the present invention is a polishing method for the polishing of the edge surface of an optical ferrule, characterized by the fact that it encompasses the following technological processes:

the technological process of providing an optical connector ferrule edge surface polishing tape that has a substrate material used for polishing tapes, and a polishing layer that is provided on the top of this substrate material, where the substrate material that is used n the above described polishing tape is a polyester film that has a thickness in the range of 50 ~ 100 microns, and where the polishing layer that is provided on the top of the above substrate material contains polishing particles that are formed from silica particles that have an average particle diameter in the range of 5 ~ 30 microns, and a binder agent that binds these particles, and also where the center line average roughness Ra of the surface of the polishing layer is in the range of 0.005 ~ 0.2 microns;

the technological process where the polishing tape is placed on the top of a rotating metal plate with an elastomer elastic material inserted between them;

the technological process where as the rotating metal plate is rotated, together with that water is used as a lubricating agent and while that water flows, the edge surface of the optical connector ferrule, that is formed from the optical fiber and the covering part that covers this optical fiber, is pushed against the polishing layer of the polishing tape..

[0016]

The invention according to Claim 5 of the present invention is a polishing equipment for the polishing of the edge surface of an optical ferrule, where
a rotating plate,
a substrate material used for polishing tapes,
a polishing layer that is provided on the top of that substrate material,
a mechanism for the rotation start-up of the above described rotating plate,
a device for supplying water or alcohol as the lubricating agent, onto the edge surface of the above described optical ferrule, are provided,

and where an optical connector ferrule edge surface polishing tape, that has a substrate material used for polishing tapes, and a polishing layer that is provided on the top of this substrate material, and where the substrate material that is used in the above described polishing tape is a polyester film that has a thickness in the range of 50 ~ 100 microns, and where the polishing layer that is provided on the top of the above substrate material contains polishing particles that are formed from silica particles that have an average particle diameter in the range of 5 ~ 30 microns, and a binder agent that binds these particles, and also where the center line average roughness Ra of the surface of the polishing layer is in the range of 0.005 ~ 0.2 microns, is placed on the top of the above described rotating plate,

and where the edge surface of the optical connector ferrule, that is formed from the optical fiber and the covering part that covers this optical fiber, is pushed against the polishing layer of the above described polishing tape.

[0017]

According to the present invention, the polishing layer contains a mixed material that is formed from silica material particles and magnesium oxide particles that have an average particle diameter in the range of 5 ~ 30 microns, and it has a center line average roughness of the surface Ra, in the range of 0.005 ~ 0.2 microns, and because of that a polishing is conducted so that there is no scratching of the edge surface of the optical connector ferrule, and also, there is no generation of step difference in the space between the ferrule and the optical fiber that is appropriate for designing an improvement of the optical properties, and especially the reflection decrease amount.

[0018]

[Implementation conditions of the present invention]

Here below, the figures will be clarified and the conditions of the practical implementation of the present invention, will be explained. Figure 1 through Figure 4 are figures that represent the conditions of the practical implementation of

the present invention.

[0019]

In Figure 1, the optical connector ferrule 1 is shown, that is formed from the optical fiber 2 and the cover part 3 (ferrule) that covers this optical fiber 2. Relative to the optical fiber 2, of the edge surface 1 a of such optical connector ferrule 1, and the cover part 3, a final finish polishing is conducted by using the polishing tape used for the polishing of the edge surface of the optical connector ferrule (illustrated by Figure 1). Moreover, in the optical connector ferrule 1, the optical fiber 2 is formed from a quartz etc., glass material, and also, the cover part 3 is formed from zirconia etc.

[0020]

Also, as it is shown in Figure 1, the polishing tape 10 is placed on the top of the rotating metal plate 16, with the elastomer elastic material 15 inserted in between.

[0021]

After that, according to Figure 2, an explanation is provided regarding the polishing tape 10. As it is shown according to Figure 2, the polishing tape 10 is formed from a substrate material 11, used for polishing tapes, formed from polyester film material with a thickness in the range of 50 ~ 100 microns, and depending on the requirements, from the primer layer 12, that has as its main components epoxy resin, acrylic resin or polyester resin, and also from a polishing layer 13, that is provided on the top of the substrate material used in polishing tapes 11 or the primer layer 12. Here, it is also a good option if the polishing tape 10 is formed in a sheet type of shape, and also, it is a good option if it is a band type of shape.

[0022]

Regarding the polishing layer 13, it contains abrasive material particles with an average particle diameter in the range of 5 ~ 30 microns, for example, colloidal silica particles and a binder agent that bonds these silica particles to each other.

[0023]

After that, each of the materials that are necessary for the structure will be explained and described in more details.

(1) Regarding the binder agent in the polishing layer

According to the present invention, as the binder agent it is possible to use a material that is a monomer, a prepolymer or oligomer, or a polymer etc., that has in its structure a siloxane bond (Si- O bond). For example, it is possible to use

[redacted]

polysiloxane or its derivative materials, their modified materials, or their blended materials, and especially, it is possible to use its monomer, prepolymer or oligomer, etc.

[0024]

In more details, for example, naturally, it is possible to use the monomer that forms the structure of the polysiloxane, the prepolymer or oligomer, or the polymer material, also, it is possible to use mixtures, blends, or reaction modified materials, etc., obtained from the above monomer that forms the structure of the polysiloxane, the prepolymer or oligomer, or the polymer material and, for example, monomers that form the structure, prepolymers or oligomers, or polymers of polyethylene type resin, polyvinyl chloride type resin, polyvinyl acetate type resin, polyacrylic type or polymethacrylic type resin materials, polyvinyl alcohol type resin, ethylene copolymer materials, polyvinyl acetal type resins, rubber type resins, polyester type resins, polyamide type resins, phenol type resins, amino-plast type resins, epoxy resins, polyurethane type resins, cellulose type resins, and other than that rein materials.

[0025]

If we are to provide an especially detailed explanation, according to the present invention, it is desirable to use organic - inorganic composite type polymers, their prepolymers or oligomers, etc., where prepolymers or oligomers, or polymers like polyethylene type resin, polyvinyl chloride type resin, polyvinyl acetate type resin, polyacrylic type resin, polyurethane type resin, polyester type resin etc., are used as the main chain, and in their side chains, the polysiloxane prepolymer or oligomer, or polymer, is reacted for example, by using graft polymerization, etc., and the the main chain part structure is formed as one with organic properties, and the side chain part becomes a structure that has an inorganic type of structure formed from the siloxane bonds.

[0026]

However, by the use of the above described organic - inorganic composite type polymers, there is no agglomeration of the abrasive material particles in the coating material or in the polishing layer, and it is possible to maintain a primary particle dispersed state, and these are materials that are said to have the merit point that by using them a polishing sheet is obtained that is appropriate for the fine polishing process.

[0027]

According to the present invention, the reason why as it has been described here above, the abrasive material particles can be maintained in a primary particle dispersed state, is not completely clear. However, it is suggested that as it is described

here below, if in the resin material that is used as the binder agent there is a siloxane bond present (si - O bond), n the case when as the abrasive material particles, for example, colloidal silica particles, are used, both of these materials have functional radicals that mutually have a common Si atom, and both materials have affinity properties, and the above described abrasive material particles even in the state where they are in the composition material that is used as the coating material, or in the polishing layer state where they are in a coated layer state, maintain their primary particle dispersed state, and because of that, a polishing sheet is manufactured and obtained whereby it is possible to conduct an extremely good final finish polishing.

[0028]

Also, according to the present invention, as the binder agent, it is possible to use polyethylene type resin, polyvinyl chloride type resin, polyvinyl acetate type resin, polyacrylic or polymethacrylic type resin, polyvinyl alcohol type resin, polyvinyl acetal type resin, rubber type resin, vinyl chloride - vinyl acetate type copolymer resin material.

[0029]

Especially, according to the present invention, from the point of view of the dispersibility properties of the abrasive material particles, the hardness of the polishing layer, the adhesive properties with the substrate material that is used in polishing tapes, it is preferred to use vinyl chloride - vinyl acetate copolymer resin material.

(2) Regarding the primer layer

According to the present invention, as the primer layer, it is possible to be formed by coating or printing of a composition material where, for example, one type or more of monomers that form the structure of polyvinyl chloride resin, polyvinyl acetate type resin, polyacrylic type or polymethacrylic type resin, polyvinyl alcohol type resin, ethylene copolymer resin, polyvinyl acetal type resin, rubber type resin, polyester type resin, polyamide type resin, phenol type resin, amino-plast type resin, epoxy type resin, polyurethane type resin, silicone type resin, cellulose type resin, and other than that resins, also their prepolymers or oligomers, or their polymers, can be used as the main components of the vehicle.

[0030]

Especially, in order to increase the adhesion properties it is also a good option to incorporate a curing agent like isocyanate etc.

(3) Regarding the abrasive material particles in the polishing layer

According to the present invention, as the abrasive material particles it is possible to use silica (silicon oxide). The Mohs hardness of the silica is in the range of 6 ~ 7, and when the Mohs hardness of the abrasive particles that have been used in the polishing tapes according to the previous technology is, in the case of alumina (aluminium oxide) 8.8, for silicon carbide, it is 9.5, for diamond it is 10.0, is considered, it is a relatively low hardness. And because of that, as it has been described here above, there is no scratching of the edge surface of the optical connector ferrule or selective polishing of the optical fiber and generation of a step in the space between the ferrule and the optical fiber. On the other hand, in the case of the silica that has a Mohs hardness number in the range of 6 ~ 7, there is a sufficient polishing force in order to eliminate the polishing scratches on the edge surface of the optical connector ferrule, that have been generated by the previous treatment which is the rough polishing, and the processing deformations.

[0031]

Then, according to the present invention, in order to solve the problem of the above described polishing scratches and steps, it is desired that the above described silica particles have a particle diameter that is less than 1 micron, and preferably, that a colloidal silica is used where the particle diameter is in the range of 5 ~ 30 micro microns.

[0032]

Also, according to the present invention, as the polishing particles in the polishing layer, it is possible to use a mixed material containing colloidal silica where the particle diameter is in the range of 5 ~ 30 mu, and magnesium oxide particles with the same particle diameter in the range of 5 ~ 30 mu. The Mohs hardness number of the magnesium oxide is 6, and it has a hardness that is close to that of the silica material.

[0033]

According to the above described, the magnesium oxide particles have an effect as a filler agent in the polishing layer. Namely, by the addition of the magnesium oxide particles, the density of the polishing particles inside the polishing layer is increased, and at the time of the polishing technological process, the polishing particles are effectively used. Also, the magnesium oxide particles have an action as a lubricating agent and because of that they have an effect of controlling the scratches.

[0034]

Then, the magnesium oxide is a material that among the oxide has a relatively high heat conducting properties, and because of that by its addition to the polishing layer, the heat conducting properties of the polishing layer are increased and it is a material that has merits from the point of view that the frictional heat is dissipated

and the durability properties are increased.

[0035]

According to the above described, as the compounding proportion of the silica particles and the magnesium oxide particles, for example, it is possible to use a material where the silica particles are mixed relatively to the magnesium oxide particles from a ratio of 90 weight parts relative to 10 weight parts, to a ratio of 95 weight parts to 5 weight parts.

[0036]

According to the present invention, because a polishing is conducted so that there is no scratching of the edge surface of the optical connector ferrule, and also, there is no generation of step difference in the space between the ferrule and the optical fiber, it is most preferred that abrasive particles are used where the average particle diameter is in the range of 5 ~ 30 mu.

[0037]

By using such polishing tape, the edge surface 1 a of the optical connector ferrule 1, is polished. After that, the polishing method for the polishing of the edge surface 1 a of the optical connector ferrule 1, will be explained by using the diagrams in Figure 3 (a) and (b) and in Figure 4.

[0038]

First, as it is shown according to Figure 3 (a) and Figure 4, relative to the edge surface 1 a of the optical connector ferrule 1 that is formed from the optical fiber 2 and the cover part 3, a polishing is conducted with the goal to eliminate the adhesive agent in advance. Namely, regarding the optical fiber 2 of the optical connector ferrule 1, it is inserted into the cover part 3 and together with that it is fixed by using an adhesive agent (not shown in the figure) and because of that, the adhesive agent exudes and flows out from the edge surface 1 a of the optical connector ferrule 1, and in this case, it is necessary that the adhesive agent is removed in advance.

[0039]

According to Figure 3 (a) and Figure 4, on the top of the rotating metal plate 21, the SiC polishing tape 20 is placed that contains the SiC large particles, with the elastomer elastic material 20 a inserted in between them. After that, while the rotating metal plate 21 is rotated, the edge surface 1 a of the optical connector ferrule 1 is pushed against the SiC polishing tape for approximately 1 minute, without using lubrication. In this case, the body itself of the optical connector ferrule 1 is auto rotating on the top of the SiC polishing tape, and by doing that, the adhesive agent that has been adhered onto the edge surface 1 a of the optical connector ferrule 1, is

eliminated.

[0040]

After that, according to Figure 3 (b), on the top of the rotating metal plate 24, the diamond polishing sheet 22 is placed with the elastomer elastic material 23 inserted between them. After that, while the rotating metal plate 24 is rotated, the edge surface 1 a of the optical connector ferrule 1 is pushed against the diamond polishing tape 22, for a time period of approximately 4 minutes, and by that the edge surface 1 a of the optical connector ferrule 1 is roughly polished. In this case, as the lubricating agent water is used, and also, the body of the optical connector ferrule 1 itself is auto-rotated on the top of the diamond polishing sheet 22. Regarding the relationship between the rotation of the rotating metal plate 24 and the auto rotation of the body of the optical connector ferrule 1 itself, it is the same as the relationship between the shown in Figure 4, relationship between the rotation of the rotating metal plate 21 and the auto rotation of the body of the optical connector ferrule 1 itself. During the rough polishing of the optical connector ferrule 1 that is shown according to Figure 3 (b), by inserting and placing the elastomer elastic material 23 in the space between the rotating metal plate 24 and the diamond polishing sheet 22, the edge surface 1 a of the optical connector ferrule 1, the edge surface 1 a of the optical connector ferrule 1 that is entered into the diamond polishing sheet 22, is formed into a spherical surface shape.

[0041]

After that, as it is shown in Figure 1, onto the rotating metal plate 16, the polishing tape 10, according to the present invention, is placed, and also the elastomer elastic material 15 is inserted in between those. And on the surface of this polishing tape 10, the edge surface 1 a of the optical connector ferrule 1 is polished for a time period of approximately 2 minutes, while water or alcohol are used as a lubricating agent. As the lubricating agent, besides water or alcohol, it is also possible to use a surface active agent, an oil etc., usually known type of materials. Regarding the polishing layer 13 (Figure 2) of the polishing tape, as described here above, it contains silica particles that have an average particle diameter in the range of 5 ~ 30 mu, and the center line average roughness of the surface , Ra, is in the range of 0.005 ~ 0.2 u. And because of that, it is possible to polish the optical fiber 2 and the cover part 3, at a good efficiency, and there is no generation of a step in the space between the optical fiber 2 where a process modified layer has been generated, and the cover part 3.

[0042]

Namely, as it has been described here above, the cover part (ferrule) 3, that is in the optical connector ferrule 1, has a structure that is formed from zirconia, etc., hard ceramics material, and relative to the optical fiber 2 that is in the center, it is relatively more difficult to polish. Because of that, if in the polishing layer 13 of the

polishing tape 10, alumina particles or diamond particles that are larger than 1 m, are made present, and the center line average roughness of the surface, Ra, is around 0.3 u, the relatively soft optical fiber is selectively polished, and as a result from that the optical fiber 2 becomes buried inside relative to the cover part 3, and a step is generated in the space between the optical fiber 2 and the cover part 3. According to this, in the case when the optical fiber 2 is buried inside, and the edge surfaces 1 a of two optical connector ferrules 1 are protruded to each other, a gap is generated in the space between the optical fibers 2 of the two optical connector ferrule 1, and at the time of the propagation of the signal, there is the problem that a light reflection is generated.

[0043]

Contrary to that, in the case of the polishing layer 13 of the polishing tape 10 according to the present invention, the silica is in the range of 5 ~ 30 mu, and the Ra is in the range of 0.05 ~ 0.2 m, and because of that, it is possible to evenly and also precisely polish the optical fiber 2 and the cover part 3. And because of that, there is no generation of a step in the space between the optical fiber 2 and the cover part 3. At the same time, there is no generation of scratches on the optical fiber 2 and on the cover part 3, and also, during the polishing process, it is not necessary to supply a polishing liquid containing other polishing material.

[0044]

Moreover, during the polishing, there is no clogging of the polishing layer 13 of the polishing tape 10, and the whole body is gradually reduces. And because of that, the life of the polishing tape 10 is extended to the limit where the polishing layer 13 is present, and because of that, it is possible to maintain a long work life of the polishing tape 10.

[0045]

[Practical Examples]

Here below, the detailed structure of the polishing tape according to the present invention and its manufacturing method, will be explained based on practical examples.

[Practical Example 1]

Coating agent used for the polishing layer

In a resin solution containing 70 weight parts of vinyl chloride - vinyl acetate polymer (VAGH, manufactured by Union Carbide Company), 100 weight parts of toluene and 100 weight parts of methyl ethyl ketone, 100 weight parts of colloidal silica sol where the average particle diameter is in the range of 10 ~ 20 mu

[redacted]

(Organosilica sol MEK-ST, methyl ethyl ketone solvent medium, solids - 30 %, manufactured by Nissan Kasei Company) were added. And after that an ultrasound wave dispersing was conducted, and then this material was diluted by using a mixed solvent consisting of equal parts of toluene and methyl ethyl ketone, and by that, a coating agent (a) was obtained that had a viscosity of 20 mPa.s, and that was used for the formation of the polishing layer.

[0046]

Manufacturing method for the preparation of the polishing sheet

The above described coating agent used for the formation of the polishing layer was filtered by employing a filter with an accuracy of 1 u. After that, on a polyethylene terephthalate film with a thickness of 75 u (manufactured by Toyobo Company; Corona treated E5100 type, where on one side of the substrate material used for polishing tapes a corona treatment has been conducted) the above described coating agent was coated by using the reverse gravure method (oblique line plate 95 lines, plate depth 80 u), so that it was at 5 grams (dry/m2). Then it was heated and dried and after that a polishing tape was obtained that had a 3 m(dry) thickness polishing layer.

[0047]

The center line average surface roughness, Ra, of the polishing layer of the polishing tape that was obtained according to the above described method, was in the range of 0.005 ~ 0.2 u.

[0048]

By using the polishing tape that represents the product of the practical implementation of the present invention, as it is shown according to the above described Figures 1 through 4, the final finish polishing of the edge surface of the optical connector ferrule, was conducted. And as a result from that, an optical connector ferrule was obtained where there were no polishing scratches on the edge surface of the optical connector ferrule, and there was no step in the space between the ferrule and the optical fiber, and the reflection decrease amount was 40 dB or higher.

[Practical Example 2]

Coating agent used for the polishing layer

In a resin solution containing 70 weight parts of vinyl chloride - vinyl acetate polymer (VAGH, manufactured by Union Carbide Company), 100 weight parts of toluene and 100 weight parts of methyl ethyl ketone, 90 weight parts of colloidal silica sol where the average particle diameter is in the range of 10 ~ 20 mu

(Organosilica sol MEK-ST, methyl ethyl ketone solvent medium, solids - 30 %, manufactured by Nissan Kasei Company) and 3 weight parts of fine magnesium oxide particles where the average particle diameter is less than 20 mu, were added. And after that an ultrasound wave dispersing was conducted, and then this material was diluted by using a mixed solvent consisting of equal parts of toluene and methyl ethyl ketone, and by that, a coating agent (b) was obtained that had a viscosity of 20 mPa.s, and that was used for the formation of the polishing layer.

[0049]

Manufacturing method for the preparation of the polishing sheet

The above described coating agent used for the formation of the polishing layer was filtered by employing a filter with an accuracy of 1 u. After that, on a polyethylene terephthalate film with a thickness of 75 u (manufactured by Toyobo Company; Corona treated E5100 type, where on one side of the substrate material used for polishing tapes a corona treatment has been conducted) the above described coating agent was coated by using the reverse gravure method (oblique line plate 95 lines, plate depth 80 u), so that it was at 5 grams (dry/m2). Then it was heated and dried and after that a polishing tape was obtained that had a 3 m(dry) thickness polishing layer.

[0050]

The center line average surface roughness, Ra, of the polishing layer of the polishing tape that was obtained according to the above described method, was in the range of 0.005 ~ 0.2 u.

[0051]

By using the polishing tape that represents the product of the practical implementation of the present invention, as it is shown according to the above described Figures 1 through 4, the final finish polishing of the edge surface of the optical connector ferrule, was conducted. And as a result from that, an optical connector ferrule was obtained where there were no polishing scratches on the edge surface of the optical connector ferrule, and there was no step in the space between the ferrule and the optical fiber, and the reflection decrease amount was 40 dB or higher.

[Practical Example 3]

Coating agent used for the polishing layer

To 80 weight parts of an organic - inorganic composite polymer - silicone resin solution (manufactured by Nippon Gosei Rubber: ceramic coat material grasca HPC 7502, methanol solvent medium, solids - 31 %), 20 weight parts of colloidal silica sol

where the average particle diameter is in the range of 10 ~ 15 mu (Organosilica sol IPA-ST, isopropyl alcohol solvent medium, solids - 30 %, manufactured by Nissan Kasei Company) were added. And after a coating agent (c) was obtained that had a viscosity of 20 mPa.s, and that was used for the formation of the polishing layer.

[0052]

Manufacturing method for the preparation of the polishing sheet

The above described coating agent (c) used for the formation of the polishing layer was filtered by employing a filter with an accuracy of 1 u. After that, on one side of a substrate material used for polishing tapes that represents a polyethylene terephthalate film with a thickness of 75 u (manufactured by Toyobo Company; treated for easy adhesion, type K 1531), the above described coating agent was coated by using the reverse gravure method (oblique line plate 95 lines, plate depth 80 u), so that it was at 5 grams (dry/m2). Then it was heated and dried and after that a polishing tape was obtained that had a 3 m(dry) thickness polishing layer.

[0053]

The center line average surface roughness, Ra, of the polishing layer of the polishing tape that was obtained according to the above described method, was in the range of 0.005 ~ 0.2 u.

[0054]

By using the polishing tape that represents the product of the practical implementation of the present invention, as it is shown according to the above described Figures 1 through 4, the final finish polishing of the edge surface of the optical connector ferrule, was conducted. And as a result from that, an optical connector ferrule was obtained where there were no polishing scratches on the edge surface of the optical connector ferrule, and there was no step in the space between the ferrule and the optical fiber, and the reflection decrease amount was 40 dB or higher.

[0055]

[Results from the present invention]

According to the present invention, the polishing layer contains silica material particles where the average particle diameter is in the range of 5 ~ 30 mu, and the center line average surface roughness, Ra, is in the range of 0.005 ~ 0.2 u, and because of that, polishing is conducted whereby there were no polishing scratches on the edge surface of the optical connector ferrule, and there was no step in the space between the ferrule and the optical fiber, and an optical connector ferrule is obtained where the reflection decrease amount was 40 dB or higher.

[redacted]

[Detailed explanation of the figures]

[Figure 1]

Figure 1 represents a diagram showing the polishing technological process by using the polishing tape according to the present invention.

[Figure 2]

Figure 2 is a diagram showing the layer structure of the polishing tape.

[Figure 3]

Figure 3 is a diagram showing the polishing method for polishing the edge surface of the optical connector ferrule.

[Figure 4]

Figure 4 is a figure showing the relationship between the rotating metal plate and the optical fiber.

[Explanation of the signs]

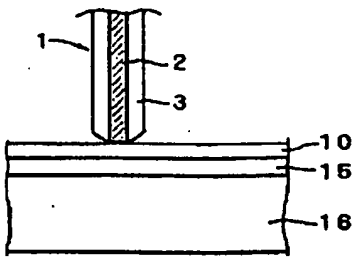
1.....optical connector ferrule
1 a.....edge surface
2.....optical fiber
3.....cover part
10.....polishing tape
11.....substrate material used for polishing tapes
12.....primer layer
13.....polishing layer

Patent Assignee: Dai Nippon Insatsu Company

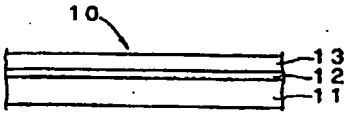
Translated by Albena Blagev (704-7946)

1/28/98

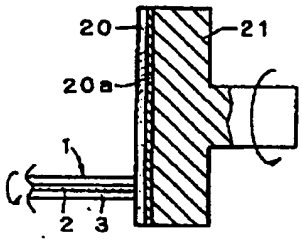
【図1】



【図2】



【図4】



【図3】